where the complex anatomy of the sinuses, sinotubular junction, and coronary ostia make TEVAR with debranching procedures or branched endografts unfeasible with current technology. Their work suggests that in identifying an endovascular solution to the ascending aorta, a valved conduit addressing the coronary arteries may need to be considered as an option.

Study Limitations

Limitations of this study include its retrospective nature over a long study period. Small differences in operative technique and perioperative care may have affected outcomes, although this was not borne out after statistical analysis based on era of operation. Another limitation included the lack of complete follow-up with regard to secondary outcome of reoperation. However, the robust sample size and long interval of the study may have mitigated the effects of this limitation.

CONCLUSIONS

We have presented one of the largest series of open repair of aortic arch pathology reported in the literature. Our data suggest that this once dreaded clinical scenario can be addressed with low rates of morbidity and need for reoperation in the treated segments. As the therapy of aortic disease evolves into a more endovascular-based approach, certain subgroups of patients, such as those with advanced age or impaired renal function, emerge as ideal candidates for this application of newer technology.

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Discussion

Dr Alberto Pochettino *(Philadelphia, Pa)*. An outstanding presentation from master surgeons. It is particularly impressive to me that you have a 100% follow-up. I am somewhat envious of that. I found as I reviewed the article that you provided to me that your use of RCP and selective antegrade perfusion was sensible in my mind and very safe, which led to the outstanding results. I have a couple of comments.

The first one relates to using the data that you have from this series as a benchmark against which newer techniques can be measured. The majority of your reconstruction involved aortic root reconstruction in what we would call arch hemi or arch total arches. That group, even with today's technology, is not amenable, I don't think, to hybrid reconstruction. So I think it would make sense to look at the isolated arches or isolated arches plus descending reconstruction that you had and use that group, which accounts for approximately 13% of your patients, as a benchmark against which the arch hybrid should be compared. Do you have data on that group?

Dr Patel. We have not separated the analysis out specifically on that basis, but we appreciate your comments, understanding the current limitations of endograft technology. However, we do know that endograft technology is progressing to the ascending aorta and may soon include ascending and root procedures as well, and we believe that these data should be compared with contemporary open surgical procedures, such as that described here. But we fully understand and appreciate your comments.

Dr Pochettino. My next comment is about aortic dissection. As you know, I have come to use what has been described as a frozen elephant trunk in the treatment of acute type A dissection. You have a large series of patients with type A dissection, and it would be useful again as a comparison against which we should look at

newer technology at the patients undergoing the DeBakey 1 procedure and how they fare both in terms of freedom from reoperation and survival. Do you have data on the DeBakey 1 cohort?

Dr Patel. We did not stratify the analysis based on extent of dissection. Just having been involved in a few of these procedures, I can suggest to you that a majority of these patients truly had dissections that extended throughout the aorta, but unfortunately I do not have that separate analysis as you have requested.

Dr Pochettino. One last question. I noticed from your article that you have changed your total arch reconstruction from an island to individual segments, to either all 3 of the vessels or at least 2. Have you noticed a decrease in the stroke rate as you changed your technique?

Dr Patel. That is a great question. Unfortunately, I did not separate this out into the island versus the individual bypass graft technique. We will tell you, as probably other surgeons have described, some of the bleeding risks may be less with the individual bypass technique, and we evolved toward that. My senior partner, Mike Deeb, evolved toward that when I was a resident in 2001, and since then we have virtually exclusively used the multibranch grafts that are available to us.

Dr Pochettino. Outstanding series.

Dr John Ikonomidis *(Charleston, SC)*. Himanshu, congratulations on a beautifully presented study of a large population of aortic arch reconstructions. I have a 2-part question for you. I wonder if it is really appropriate when one considers stroke rates to group hemi-arch replacements with total arch replacements, because I think technically they are 2 different operations. An aortic arch reconstruction involves more manipulation of the great vessels, and one would expect intuitively that it would be associated with a higher stroke rate, and therefore including hemi-arches in the analysis would somewhat buffer that effect. My first question is, did you separate out hemi-arches from full arches, and what were the relative stroke rates in those? Related to that, did you include requirement for total arch replacement in your multivariable analysis to see if that was an independent predictor of stroke?

Dr Patel. When we analyzed the incidence of stroke, we did include the extent of resection in that analysis, and as a surrogate, extension into the descending aorta was identified as an independent risk factor for stroke. However, whether we used 1, 2, or 3 bypasses really did not separate out on univariate or multivariate analysis as a risk factor for stroke.

I will tell you that in our series, the neuroprotection strategy, whether it was just isolated RCP or a combination of RCP and ACP, really did not make a difference whether we saw postoperative stroke or not, and I suspect that it is partly because it is drowned in the numbers, because the bias obviously is that when we extended to a total arch repair, we would typically use ACP. If you look at the cerebral ischemic times that were calculated out for each patient, the cerebral ischemic time for the entire cohort was approximately 15 or 16 minutes, whereas the total lower body circulatory arrest time was approximately 30 to 35 minutes. So a significant proportion of patients did have an antegrade cerebral approach, and perhaps that may have mitigated the effects of extended arch reconstruction and its effects on stroke as well.

Dr Ali Khoynezhad *(Omaha, Neb)*. Himanshu, that was an excellent presentation with great results. A question about a subset (the patients with type A aortic dissection): Not surprisingly, they had a higher early mortality, reoperation, and probably a higher stroke rate. Did you look into different cannulation sites, such as femoral or axillary cannulation for HCA, and did you find any difference in outcome of those patients? Also, was there any difference in outcomes by using transcranial Doppler? I adopted it early on, and this was before, especially since Dr Safi's group showed improvement of outcomes by utility intraoperative modification of the cannulation site when patients went on or came off pump to reduce cerebral malperfusion.

Dr Patel. We typically do not use other adjunctive maneuvers to determine whether there are changes in cerebral perfusion, such as cerebral oximetry and so on. The cannulation strategy in acute type A dissection evolved throughout the study. The majority of patients early on, and I would say until about 2005 or so, were cannulated usually through femoral access in the setting of acute type A dissection. In the setting of elective aneurysm or urgent aneurysm repair, if the pathology allowed it, meaning if it wasn't very calcified or so on, we would usually cannulate the ascending aorta and go on bypass that way. We have done axillary perfusion in a smaller number of patients who presented with an acute type A dissection, but that is more recently, within the last 3 or 4 years. I unfortunately don't have the data separating it out on the basis of cannulation site as a marker for stroke, but I do understand that there has been literature prescribing axillary approaches to reduce the risk of stroke.

Dr Anthony Estrera *(Houston, Tex)*. Himanshu, a nice job. I think one of the deceptive things when you present your data is your late reintervention rate, because the reality is how many of these patients you had to reintervene for the arch portion of the graft, because if you are going to compare this with endovascular therapies, one of the main limitations with endovascular therapies are all these endoleaks related to the graft. The reality is most of your late reinterventions are related to progression of disease distal to your arch graft, and I would presume that your arch repairs are very durable. So if you could present some of that data, I think it would be helpful when you are comparing it as a contemporary series.

Dr Patel. If I remember correctly in the analysis, there may have been only 1 person who underwent reoperation in this entire series that we know of who had an anastomotic issue, and that was a patient who actually came in with an infected proximal suture line and developed a pseudoaneurysm requiring a root and partial ascending reconstruction. But you are absolutely correct, the majority of late reoperations are secondary to progression of disease in other aortic segments, not the treated aortic segment, as you would expect.